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(54) Processing waste

(57) A method of and an apparatus for processing waste such as waste rubber and plastics and especially old tyres is disclosed. The waste is coarsely comminuted, thermally decomposed in a single fluidised bed with the application of a fluidising medium comprising oxygen, and any metal components of the waste are continually drawn off from the fluidised bed. An apparatus for processing the waste comprises a charging chamber (6), a feeder wheel (12) rotatably drivable about a substantially horizontal axis for forcing comminuted waste into a fluidised bed reactor (14). Extractor means comprising a belt (21) and magnetic separating device (22) is provided to remove metal residues and pass them to a scrap container (24).

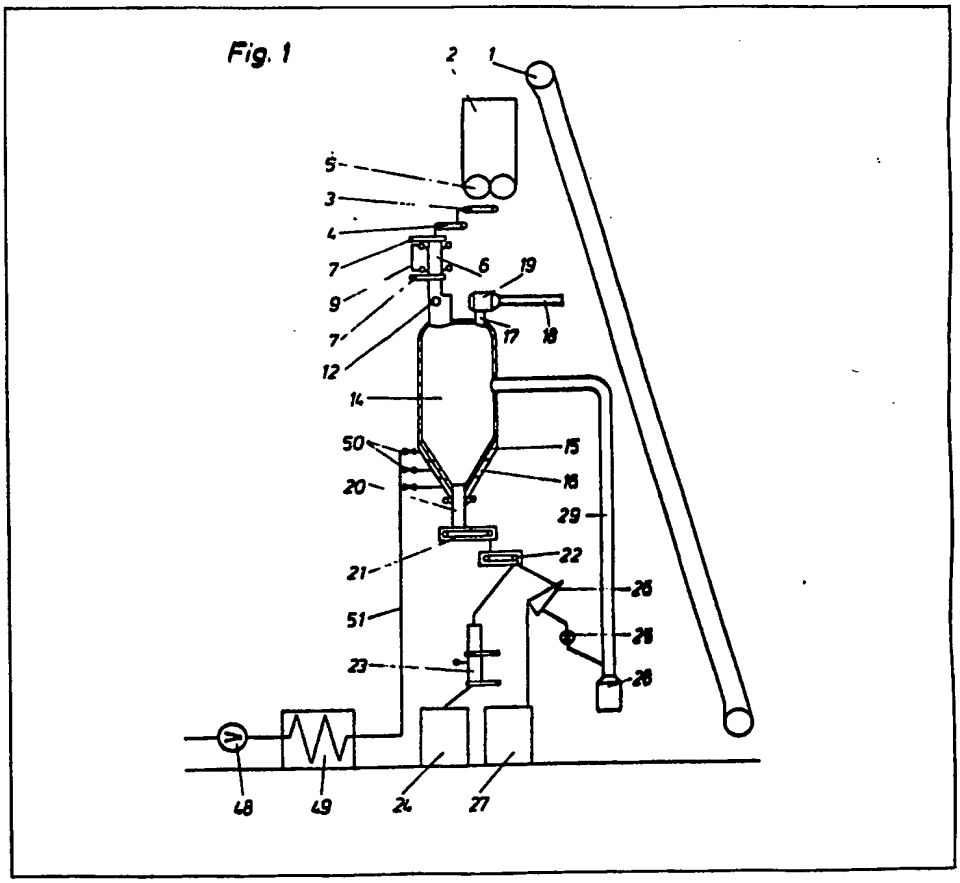

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Fig. 1

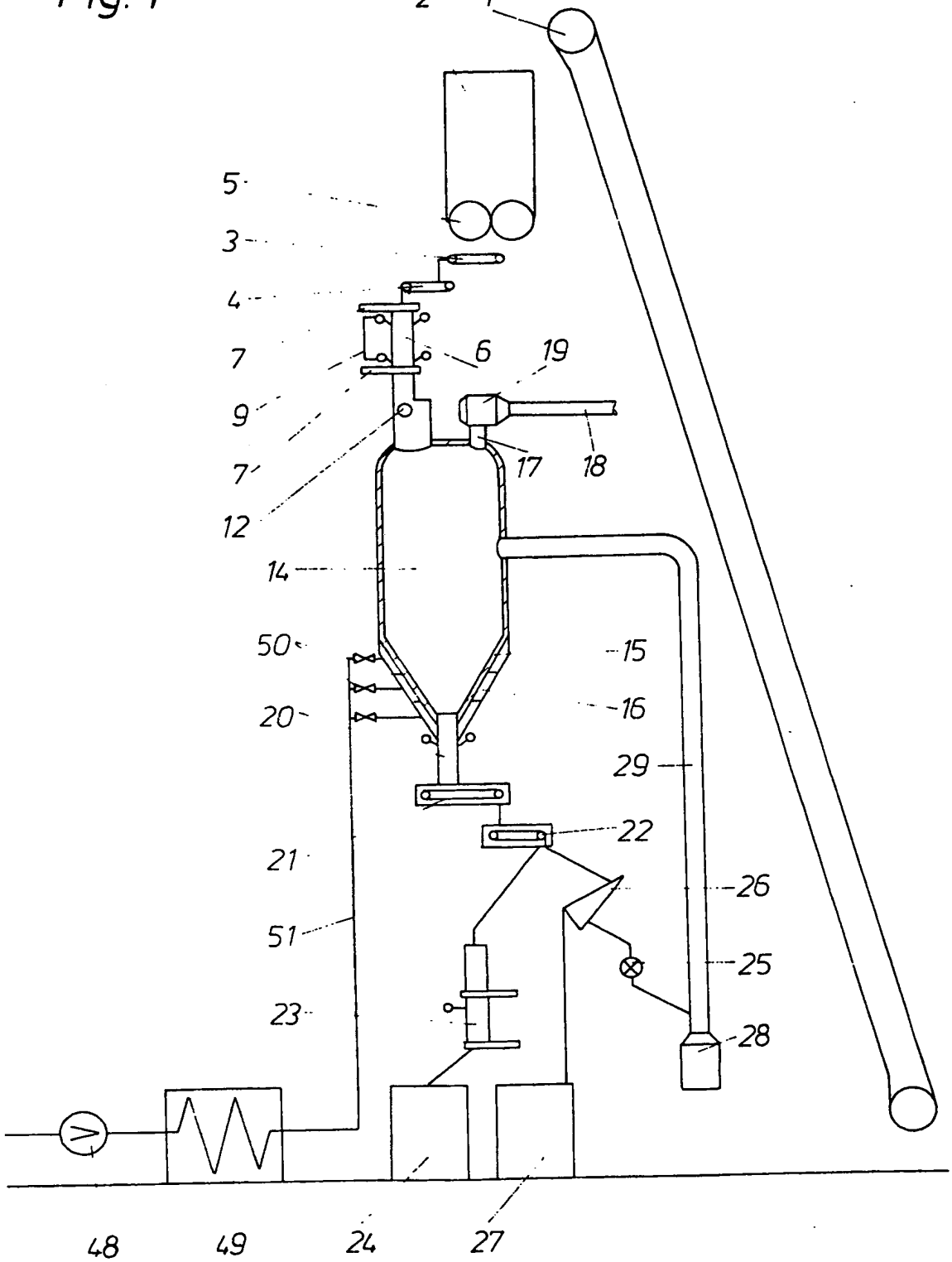
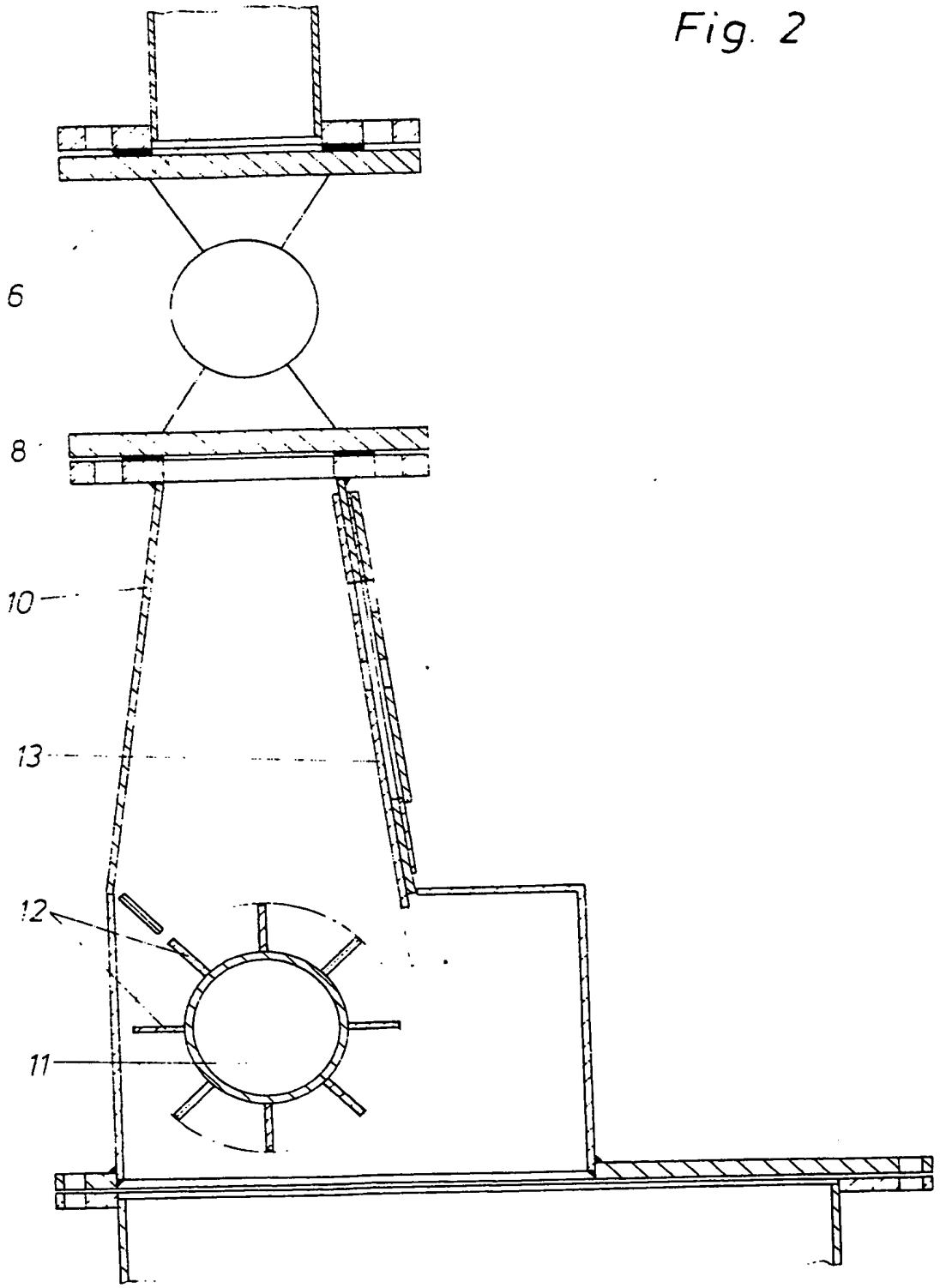


Fig. 2



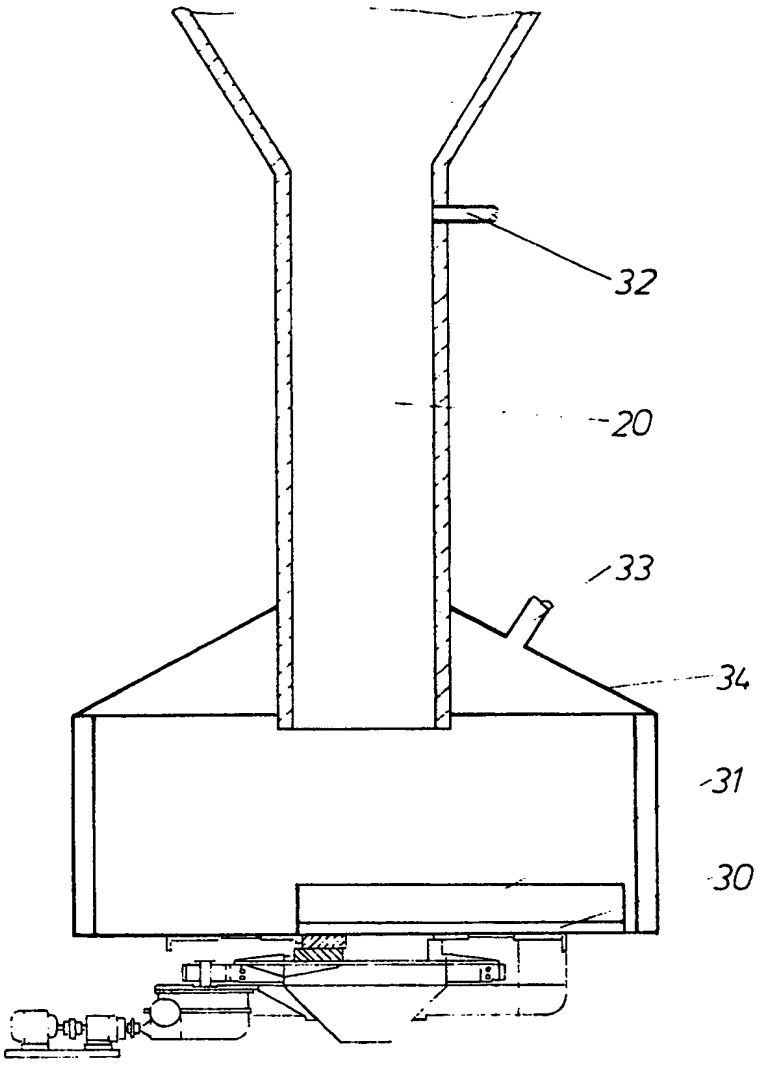


Fig. 3

Fig. 4

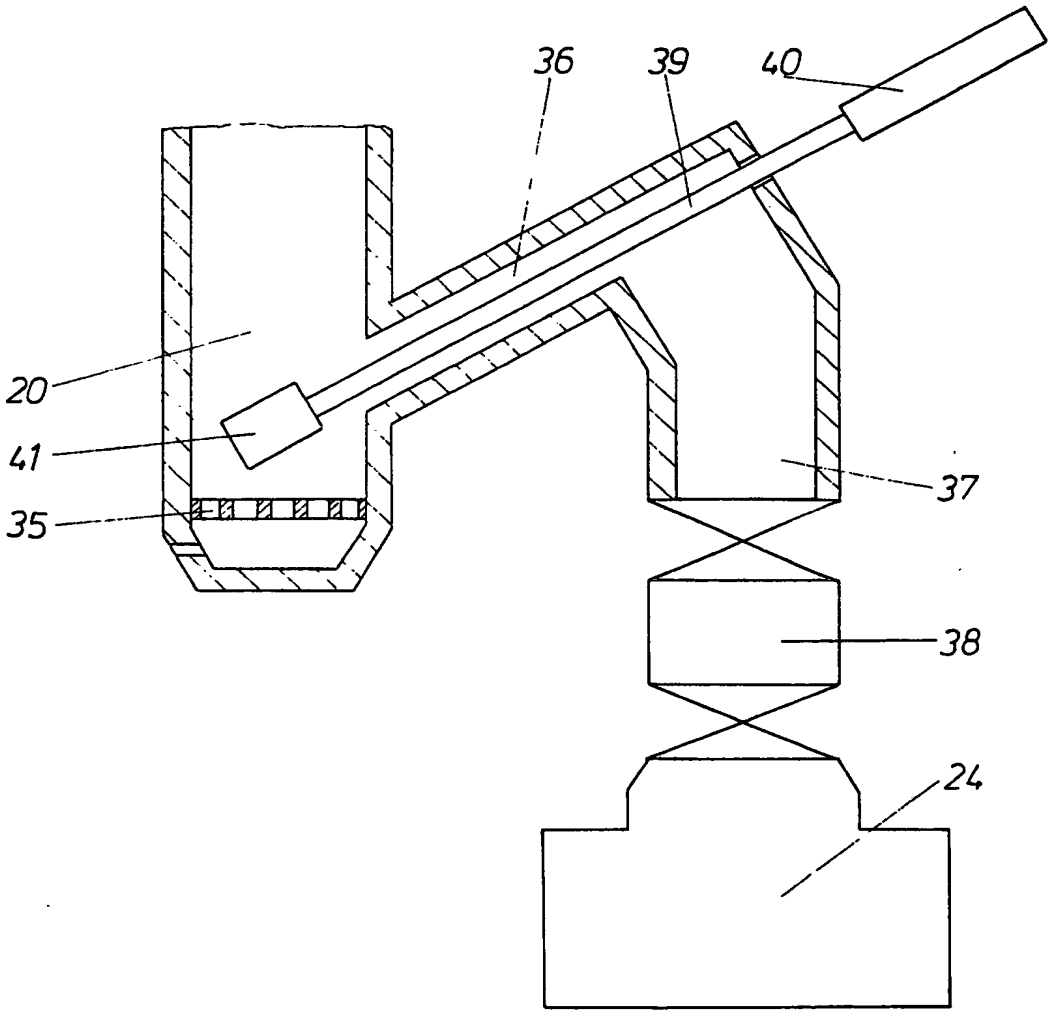


Fig. 5

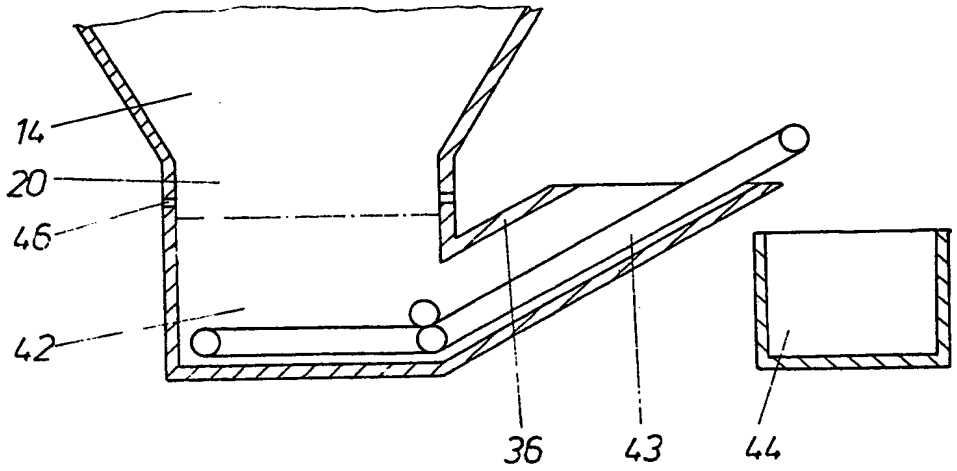
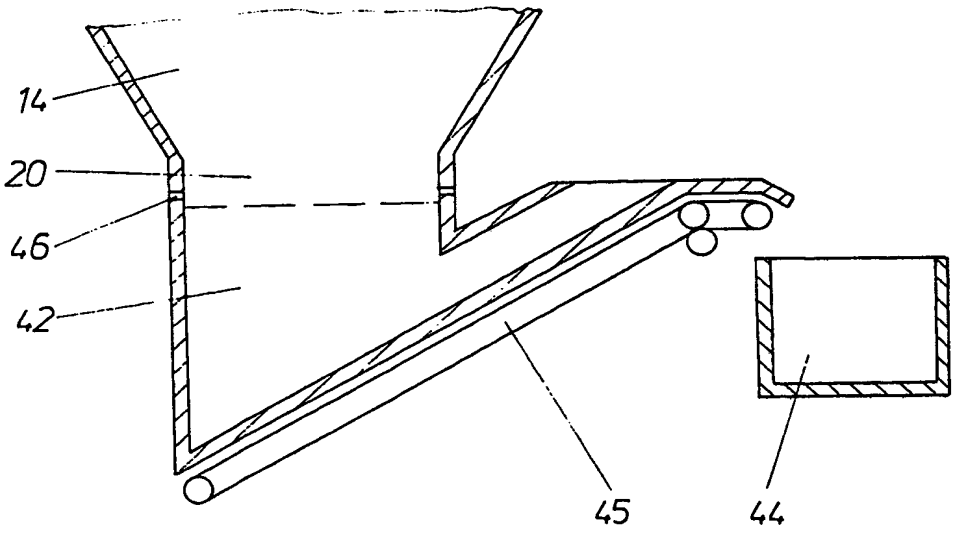


Fig. 6



SPECIFICATION

Method of and apparatus for processing waste

The present invention relates to a method of and to an apparatus for processing waste such as rubber and plastics waste, especially old tyres, in which the waste is coarsely comminuted and then is thermally decomposed in a fluidised bed.

It is known that rubber and plastics waste, and also old tyres, can be utilized by pyrolysis for the purpose of recovering recycling products or heating oil and heating gas. In pyrolysis the yield of high-quality products is low. Likewise, the use in combustion plants of the gas or oil obtained by pyrolysis with subsequent condensation appears uneconomical.

Pyrolisis of these waste materials can be carried out in rotary kilns, shaft furnaces, tube reactors, fluidised beds and salt baths. Where a sand fluidised bed is used, it is known that the energy necessary for the pyrolysis can be introduced through steel tubes incorporated into the fluidised bed reactor. Furthermore, it is known that two fluidised bed reactors may be connected one behind the other, in the first of which rubber waste is carbonized and in the second the granulation and gasification are carried out.

The pyrolysis of old tyres presents difficulties when the tyres have steel inlays such as wires and wire fabric. In such methods it has not so far proved possible to remove these metal residues continuously. The known processes therefore can only operate on the batch principle.

According to one aspect of the present invention there is provided a method of processing waste comprising the steps of coarsely comminuting the waste, thermally decomposing the waste in a single fluidised bed with the application of a fluidising medium comprising oxygen, and continually drawing off from the fluidised bed any metal components of the waste.

The waste materials may be charged by batches and then supplied continuously to the fluidised bed. With this method, it becomes possible to carry out continuously the supplying of the granulated waste and the removal of remaining metal residues, so that the process as a whole can proceed continuously. By the combining of the operations relating to the production of combustible gas in one fluidised bed the process is simplified. This process is simple to control, so that the resultant combustible gas is produced at a uniform rate and with a uniform quality.

According to another aspect of the present invention there is provided an apparatus for processing waste, comprising a charging chamber, a feeder wheel rotatably drivable about a substantially horizontal axis and disposed downstream of an outlet of the charging chamber, a counter-surface spaced from the feeder wheel at a distance which is smaller than the intended mean particle size of the comminuted waste and a fluidised bed reactor to receive the comminuted particles and provided with means for the removal of the metal therefrom.

In this apparatus, a column of granulated waste materials, from which individual pieces are fed into the fluidised bed by the feeder wheel, is disposed between the charging lock and the feeder wheel. The feeder wheel may be replaced by a piston assembly or a screw.

For removing the metal residue a gastight, sealed closure to the fluidised bed must be assured, and due to the bulkiness of the metal waste no mechanical seal can be considered here. In an embodiment of the invention the fluidised bed reactor is provided with a conical lower end portion, which terminates in a central discharge pipe. In the discharge pipe a column of material is provided, which is adjoined by an extractor apparatus. This column of material may be formed by a standing column, fluidised bed or a liquid.

Embodiments of the present invention will now be more particularly described by way of example and with reference to the accompanying drawings in which:

Figure 1 shows in longitudinal section an embodiment of the invention;

Figure 2 shows an apparatus for introducing the waste materials, and

Figure 3 to 6 show embodiments of devices for extracting metal residues.

Referring to the accompanying drawings the apparatus comprises a conveyor 1, which supplies granulated rubber or plastics waste, such as granulated used tyres, to a storage vessel 2. The storage vessel 2 is provided in its lower part with extractor rolls 5, which feed the granular material via an intermediate belt 3 to a belt weighing machine 4. The extractor rolls 5 have the additional task of keeping foreign objects above a certain size away from the succeeding reactor, in that these rolls are stopped if pieces that are too hard for example bits of steel, pass through.

Underneath the belt weighing machine 4 there is a charging chamber 6, provided with an upper and a lower cut-off slides 7, a double-bell closure or ball valves 8 could be used. The cut-off slides 7 can be water cooled. The charging chamber 6 is scavenged with inert gas or steam to seal against escape of gas. The feed of the scavenging medium is provided by a piping system 9.

Beneath the charging chamber 6 there is a housing component 10, which may widen out downwards (Figure 2). Mounted in this housing component 10, is a driven feeder wheel 11 with a horizontal axis. Entraining devices or sheet metal strips 12 are fitted at the periphery of the feeder wheel 11. Between the sheet metal strips 12 chambers are formed. Between the feeder wheel 11 and the housing wall 13 opposite to it there is a gap, which is somewhat smaller than the average particle size of the granulated waste materials. The width of the gap may be varied to increase or decrease it by displacing the housing wall 13. The material charged intermittently through the charging chamber 6 builds up in the housing component 10 and is pressed through the gap between the feeder wheel 11 and housing wall 13, when the feeder wheel 11 revolves and in this way is continuously supplied to the succeedingly connected reactor. If the gap width is sufficiently

small by comparison to the particle size of the waste, the gap width has practically no effect upon the delivery rate of the feeder wheel 11. In order to regulate the throughput of the reactor, the feeder wheel 11 may be equipped with an infinitely adjustable drive.

The axis of the feeder wheel 11 or the housing wall 13 may be spring-mounted. Instead of a system comprising a feeder wheel 11 and a housing wall 13, two feeder wheels may be used, these being located at a suitable distance from each other. The second feeder wheel may also be driven. In this case the two feeder wheels may be driven at the same or at different speeds. Above the feeder wheel 11, a supply connection for nitrogen may be provided in the housing component 10.

The same manner of continuously feeding the granulated old tyres into the reactor can also be achieved if horizontal duct leads into the reactor beneath the charging chamber 6. The granulated waste material present in the duct is pressed either by means of a piston or by means of a screw into the reactor.

The material conveyed by the feeder wheel 11 arrives in the actual reactor 14, which comprises a lined cylindrical and a conical portion and in which a fluidised bed is maintained with the use of a finely granulated, heat-resistant material. For such a material, sand, limestone, clay, rock, ore and similar materials in appropriate particle size may be used. Preferably sand is used. Where mention is made below of sand, this could equally well be replaced by another material.

The conical part of the reactor 14 constitutes the blowing base 15 of the fluidised bed and is surrounded by a plurality of annular ducts 16, out of which the cold or preheated fluiding air, optionally with an addition of steam, flows through shielded nozzles into the reactor 14. The subdividing of the blowing base 15 into a plurality of sections provided by the annular ducts 16 permits a good control of the fluidising air flow rate and the desired influencing of the fluidised bed.

In the sand fluidised bed inside the reactor 14, the rubber waste material is gasified and is converted into a product gas, which comprises organic compounds, carbon monoxide, hydrogen and nitrogen and contains fairly quantities of soot. The product gas passes out through a connection 17 from the reactor 14 and is conducted via a product gas line 18 directly to the place of used. Soot deposits can be prevented by the incorporation of a twist apparatus 19 into the product gas line 18, which imparts a spiral movement to the product gas.

Where old tyres are used, only the metal residues present in them are left over. The metal residues must be continuously removed. For this purpose the conical blowing base 15 terminates in a central discharge pipe 20. The apex angle of the conical blowing base 15 is chosen at such a size that the metal residue can slide on it. In the present case, the angle of slope of the blowing base 15 is approximately 60°.

The fluidised bed, at approximately 800°C, inside the reactor 14 must be sealed gastight from its external surroundings. Due to the bulkiness of the metal residue mechanical sealing is not possible. Provision is therefore made for the sealing to be effected by the bulk materials column of the metal residue inside the discharge pipe 20, the bulk materials column comprising the sand of fthe fluidised bed. The bulk materials column stands on an extractor apparatus.

According to Figure 1, the extractor apparatus comprises a gastight encapsulated removal belt 21, which can be provided with entraining devices. Downstream of the belt 21, a gastight encapsulated magnetic separating apparatus 22 is provided, as a magnetic roll or as a belt magnet. The magnetic metal residues pass, via a lock 23 which is equipped with slide valves or other closure devices and may widen out towards the bottom, into a scrap container 24. The remaining constituents are separated on a sieve apparatus 26 into fine sand and coarser constituents. The coarser constituents pass into a waste vessel 27 and the fine sand via a cell wheel 25 into a pneumatic conveyor 28. The pneumatic conveyor 28 conveyors the sand via a return line 29 back into the reactor 14. Air and/or steam are used as the propelling medium. The conveying length may be such that the sand conveyed back into the reactor 14 is distributed uniformly over the surface of the fluidised bed.

According to Figure 3, a rotating plate 30 with a stripper 31 is disposed beneath the discharge pipe 20. To improve the sealing action, air is blown through an inlet pipe 32 into the upper part of the discharge pipe 20. This air acts as sealing air and fluidising air and maintains the sand in the fluidised state. Sealing air which penetrates through the material column comprising metal residues and sand can be extracted through an outlet connection 33. This outlet connection 33 is mouted on the housing 34 surrounding the revolving plate 30.

In the embodiment illustrated in Figure 4 the discharge pipe 20 is closed at the bottom by a horizontal blowing base 35. The wall of the discharge pipe 20 is adjoined by an inclined duct 36, the rear end of which is closed. The duct 36 continues downwards into vertical shaft 37, which is closed by a gastight extraction lock 38. In this embodiment, a solid closure plate can be provided instead of the horizontal blowing base 35, in which case the fluidising air is blown in through lateral nozzles. Through the duct 36, an electromagnet 41 is guided into the fluidised bed on a pistion rod 39 by means of a cylinder 40 mounted externally on the wall of the duct 36. The stroke is so designed that the electromagnet 41 can travel fro%m one limiting position above the horizontal blowing base 35 into another limiting position inside the shaft 37. When the electromagnet 44 penetrates into the fluidised bed it picks up the magnetic consituents from the decomposed waste, e.g. from tyres, which has collected on the blowing base 35. If the electromagnet 41 is then retracted into its other limiting position and the excitation current is shut off, then the collected metal residues pass through the shaft 37 and via the extraction lock 38 into the scrap container 24. The essential advantage of this embodiment is that the

amount of sand extracted from the reactor 14 is small and complicated sand conveying devices are not required.

Instead of bulk material column in which the sand can be maintained in the fluidised state, the seal may be produced according to Figures 5 and 6 also by a vessel 42 disposed underneath the discharge pipe 20. The vessel 42 is filled with a gravity sludge, such as is used for the preparation of ores. The density of the gravity sludge is set to the value which is higher than the specific gravity of the sand but lower than that of the metal residue. If a material other than sand is used, then the density is adjusted to its specific gravity. In this gravity sludge, the metal residues therefore sink while the sand floats on the surface of the sludge.

An inclined duct 36 is connected to the side wall of the vessel 42. Through the duct 36 a circulating conveyor belt 43 provided with entraining devices is conducted down into the vessel 42. The discharge end of the conveyor belt 43 is situated above a receiving vessel 44. Instead of this conveyor belt 43, a circulating magnet may also be provided. Similarly, the metal residues may also be removed from the vessel by means of an electromagnet 41 shown in Figure 4.

Figure 6 shows a circulating magnet 45 outside the vessel 42. The base of the vessel 42 conforms to the slope of the circulating magnet 45.

Above the vessel 42 lateral nozzles 46 are provided, which may be complemented by lower nozzles. The air blown in through these nozzles is deisgned to loosen up the sand layer floating on the gravity sludge, so that the metal residues are able to sink through the sand layer into the vessel 42.

The inclined base of the vessel shown in Figure 6 may also be provided with nozzles, which replace the lateral nozzles 46 and the lower nozzles. In this case, the outlet from the lateral duct 36 is connected via an extraction lock with a closed receiving vessel 44 similarly to the embodiment shown in Figure 4.

The fluidising air required for maintaining the fluidised bed inside the reactor 14 is supplied from a blower 48 and is blown, either cold or preheated by means of a heat exchanger 49, through a pipe 51 provided with control devices 50 and through the annular ducts 16 into the reactor 14. For regulating the heat balance, steam may be added to the fluidising air. By mutual adaption of the particle size of the material for the fluidised bed, of the fluidised gas flow rate and of the throughput, a process temperature of approximately 500 to 900°C can be provided in the fluidised bed by partial gasification of for example old tyres or plastics waste and of the resultant carbonization products.

An advantage of the above described embodiments is that a continuously operating process and apparatus for the utilization of rubber and plastics waste materials in particular old tyres are provided in which a heat-rich combustion gas is developed at a uniform rate and quality.

CLAIMS

1. A method of processing waste comprising the steps of coarsely comminuting the waste, thermally decomposign the waste in a single fluidised bed with the application of a fluidising medium comprising oxygen, and continually drawing off from the fluidised bed any metal components of the waste.

2. A method as claimed in claim 1, wherein the waste is charged intermittently for the coarse comminution and supplied continuously to the fluidised bed.

3. A method as claimed in either claim 1 or claim 2, wherein the waste comprises rubber and plastics material.

4. A method as claimed in any one of the preceding claims, wherein the waste comprises tyres.

5. A method of processing waste, substantially as hereinbefore described.

6. An apparatus for carrying out the method as claimed in any one of the preceding claims, comprising a charging chamber, a feeder wheel rotatably drivable about a substantially horizontal axis and disposed downstream of an outlet of the charging chamber, a counter-surface spaced from the feeder wheel at a distance which is smaller than the intended mean particle size of the comminuted waste and a fluidised bed reactor to receive the comminuted particles and provided with means for the removal of metal therefrom.

7. An apparatus as claimed in claim 6, wherein the feeder wheel comprises entraining members.

8. An apparatus as claimed in either claim 6 or claim 7, wherein the feeder wheel comprises sheet metal strips which define chambers.

9. An apparatus as claimed in any one of claims 6 to 8, wherein the axis of the feeder wheel is resiliently mounted.

10. An apparatus as claimed in any one of claims 6 to 9, wherein the counter-surface comprises at least a part of a wall of a housing in which the feeder wheel is disposed.

11. An apparatus as claimed in claim 10, wherein the housing wall is resiliently mounted.

12. An apparatus as claimed in any one of claims 6 to 9, wherein a second feeder wheel is disposed opposite the first mentioned feeder wheel.

13. An apparatus as claimed in claim 12, wherein the second feeder wheel is drivable.

14. An apparatus as claimed in claim 13, comprising means to rotate both feeder wheels at the same speed.

15. An apparatus as claimed in claim 13, comprising means to rotate the two feeder wheels at different speeds.

16. An apparatus as claimed in any one of claims 6 to 15, wherein the spacing between the first mentioned feeder wheel and the counter-surface is adjustable.

17. An apparatus as claimed in any one of claims 6 to 16, wherein a connection for the feed of nitrogen is provided above the first mentioned feeder wheel.

18. An apparatus as claimed in any one of claims 6 to 17, comprising a substantially horizontal duct, disposed downstream of the charging chamber and provided with a piston displaceable therein.

19. An apparatus as claimed in any one of claims

6 to 18, comprising a substantially horizontal duct disposed downstream of the charging chamber and provided with a conveyor screw therein.

20. An apparatus as claimed in any one of claims 6 to 19, wherein the fluidised bed reactor comprises a conical lower end portion terminating in a central discharge pipe.

21. An apparatus as claimed in claim 20, so adapted that in operation a materials column is provided in the discharge pipe and is in communication with means for discharging the materials from the apparatus.

22. An apparatus as claimed in claim 21, comprising means so to blow air into the discharge pipe as to maintain the materials column in a fluidised state.

23. An apparatus as claimed in claim 22, wherein the discharge pipe has at a lower end portion thereof an outlet connection for the removal of barrier air.

24. An apparatus as claimed in any one of claims 21 to 23, wherein the materials column rests upon a mechanical output device.

25. An apparatus as claimed in either claim 21 or claim 22, comprising an electromagnet movable in operation between a first position inside the materials column and a second position outside the materials column and above an extraction lock.

26. An apparatus as claimed in either claim 21 or claim 22, wherein a duct having an upward inclination in a direction away from the discharge pipe is connected laterally to the discharge pipe and a removal device is adapted to be guided along the duct.

27. An apparatus as claimed in either claim 21 or claim 22, wherein a vessel provided with a lateral duct having an upward inclination in a direction away from the discharge pipe is disposed directly beneath the discharge pipe and is in operation filled with a gravity sludge, the specific density of which is less than that of iron and greater than that of the material intended to be used for the fluidised bed.

28. An apparatus as claimed in any one of claims 20, 21 or 26, wherein a circulatable conveyor belt provided with entraining devices, is guided through the duct into the vessel.

29. An apparatus as claimed in any one of claims 20, 21, or 26, wherein a circulatable magnet is disposed adjacent the duct and the vessel.

30. An apparatus as claimed in any one of claims 20, 21, or 26, wherein and electromagnet is guided through the duct into the vessel.

31. An apparatus for processing waste substantially as hereinbefore described with reference to Figure 1 of the accompanying drawings.

32. An apparatus as claimed in claim 31 and modified substantially as hereinbefore described with reference to Figure 2 of the accompanying drawings.

33. An apparatus as claimed in claim 31 and modified substantially as hereinbefore described with reference to Figure 3 of the accompanying drawings.

34. An apparatus as claimed in claim 31 and modified substantially as hereinbefore described with reference to Figure 4 of the accompanying drawings.

35. An apparatus as claimed in claim 31 and modified substantially as hereinbefore described with reference to Figure 5 of the accompanying drawings.

36. An apparatus as claimed in claim 31 and modified substantially as hereinbefore described with reference to Figure 6 of the accompanying drawings.

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